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(19)

(54) IMPROVEMENTS IN OR RELATING TO CENTRIFUGAL PUMPS

(71) We, BLAW KNOX LIMITED, a British Company of River House, Short's Way, Rochester, Kent, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the operation of centrifugal pumps.

A centrifugal pump cannot commence or continue to pump liquid unless it is in a primed condition. In one known arrangement for priming such a pump, a chamber, which is in communication with the suction inlet of the pump, is connected to a vacuum pump which is employed to extract air from the chamber and from the casing of the centrifugal pump such that liquid is drawn up into both. A valve is interposed between the chamber and the vacuum pump, the valve becoming closed if a float which is connected to the valve rises with the liquid in the chamber to a pre-determined level. Closure of the valve prevents liquid in bulk form passing from the chamber to the vacuum pump.

The invention provides a centrifugal pump; a chamber disposed generally above the suction inlet thereof; means defining a liquid flow path extending from the suction inlet to the chamber interior; a vacuum pump; means defining a first air flow path extending from the chamber interior, at an upper part thereof, to the suction inlet of the vacuum pump: means defining a second air flow path extending from the chamber interior, at an upper part thereof, to atmosphere; first valve means, responsive to changes in level of liquid in the chamber so as to maintain closed the first air flow path if said liquid is above a first level; and second valve means, independent of the first, responsive to changes in level of liquid in the chamber so as to maintain closed the second air flow path if said liquid is at or below a second level and to maintain open the second air flow path if said liquid is above the second level, the second level being above the first level and both first and second levels being below the chamber ends of the air flow paths and above the chamber end of the liquid flow path.

The invention further provides a pump unit including a centrifugal pump, a chamber disposed generally above the suction inlet of the centrifugal pump, the chamber being in communication with the said inlet, and a vacuum pump, in communication on its suction side with the chamber, wherein, when the pump unit is to be brought into operation for the purpose of pumping liquid, the vacuum pump is started and draws air from the chamber and from the casing of the centrifugal pump via the chamber, the centrifugal pump being thereby put into a primed condition, and wherein a first valve, actuated by a first float, which rises and falls with the level of liquid in the chamber, closes to isolate the chamber from the vacuum pump when the liquid reaches a first level in the chamber, and, if the liquid level continues to rise and reaches a second level, a second valve, actuated by a second float, which rises and falls with the level of liquid in the chamber, opens to put the chamber, above the liquid therein, into communication with atmosphere, whereby the liquid level in the chamber falls, thus permitting the second valve to close and then the first valve to open again.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a side elevational view of a general duty pump unit;

Figure 2 shows, with parts removed, a

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sectional view of a tank, and a suction pipe member, both of which are included in the pump unit shown in Figure 1;

Figure 3 shows a partly sectioned elevational view of the tank and suction pipe member shown in Figure 2, with parts removed, looking in the direction of the arrow A; and

Figure 4 shows a sectional view taken on line IV-IV of Figure 2.

The general duty pump unit shown in Figure 1 includes a four wheeled trailer chassis 40 on which there are mounted, towards opposite ends thereof, a centrifugal pump 11 and a twin cylinder diesel engine unit 10. Pump 11 and engine unit 10 are connected by a trunking casting 39 and are coupled by a drive shaft 41, by means of which the pump may be driven by the engine unit.

Mounted above pump 11 is a tank 13, part of the interior of which provides a float chamber 21. As may be seen in Figure 2, a lower part of float chamber 21 is provided by a downwardly extending portion 14 of the tank 13. Side walls 42 of the portion 14 extend tangentially to the walls of a circular section suction pipe member 12 of pump 11. The side walls 42 and end walls 43 of the portion 14 are sealed to the pipe member 12, and an aperture 44 at an upper part of the pipe member 12 provides a flow communication between the pipe member and the float chamber 21.

A horizontal partition plate 45 separates float chamber 21 from an upper chamber 27 of tank 13, the upper chamber being divided into right and left hand portions (looking at Figure 2) by a vertical partition plate 46 through which extends an aperture 47.

The pump unit also includes a rotary sliding vane vacuum pump 16 arranged to be driven, by means of a toothed belt 17, from the drive shaft 41. A flexible hose 18, which includes a strainer (not shown), connects the suction side of vacuum pump 16 with an aperture 28 of tank 13, which aperture communicates with the upper chamber 27 of the tank. The exhaust side of the vacuum pump 16 is connected to an exhaust pipe 19 in which is included a silencer 20 secured at the under side of the chassis 40.

Within tank 13 there is housed a peeler valve assembly 48 including a mounting plate 49 secured to partition plate 45 and overlying an aperture 50 extending therethrough. An aperture 52 of triangular section extends through a thickened part 51 of plate 49. Secured to the under face of part 51 of plate 49 and extending over the full section of the aperture 52 is a perforated metal disc 31 the perforations of which are in a triangular array (see Figure 4) conforming to the section of aperture 52, with which they communicate. Secured to mounting plate 49 and extending within the float chamber 21 is a hinge bracket 53 which carries a horizontally extending hinge pin 32. A peeler valve 24 of assembly 48 consists of a rubber diaphragm 29 which is stretched over a member 30, which member is pivotally mounted on the hinge pin 32. In the closed condition of peeler valve 24 member 30 is horizontal (in which position it is shown in Figure 2) and the diaphragm 29 lies against the under face of the perforated disc 31 and closes the lower ends of the perforations thereof.

Peeler valve assembly 48 further includes a float arm 26 which is pivotally mounted at its upper end on hinge pin 32. The arm 26 is connected to, and moves with, member 30. From its upper end, arm 26 extends downwardly within float chamber 21 at an effective angle of thirty degrees to member 30. Attached to the lower end of arm 26 is a spherical float 22 formed of stainless steel. Downward pivotal movement of arm 26 about hinge pin 32 is limited by a horizontally extending stop bar 80 secured within the float chamber. Removal of a cover plate 62 of tank 13 permits the withdrawal of the complete peeler valve assembly 48 from the tank 13.

Above the horizontal partition plate 45 of tank 13, a vertical partition plate 54 extending within the right hand portion of upper chamber 27 and a portion 55 of partition plate 46 separate from upper chamber 27 a compartment 56. Disposed within the compartment 56 and secured to the upper face of the horizontal partition plate 45 is a snifter valve 25 the vertically movable valve spindle 57 of which valve extends downwardly into the float chamber 21 through an aperture 58 in the plate 45. A cover plate 59 is secured to an end wall 81 of the tank 13 and overlies an aperture 60 in the wall, which aperture opens into the compartment 56. A vent 61 of the cover plate 59 provides the compartment 56 with a communication to atmosphere via the aperture 60.

Within the float chamber 21 there is disposed a second float arm, designated 33, which second arm is pivotally mounted at its upper end on a horizontally extending hinge pin 34 which is carried by a hinge bracket 75 secured to a side wall 76 of the tank 13. Attached to the lower end of arm 33 is a spherical float 23 formed of stainless steel. The float arm 33 has secured to it, towards its upper end, a D-shaped striker plate 35, the purpose of which is described below. Downward pivotal movement of the arm 33 about hinge pin 34 is limited by the stop bar 80.

Partition walls 63 and 64 within tank 13 separate the float chamber 21 from a compartment 36. Apertures 65 and 66, extending respectively through an under wall 67 and the side wall 76 of tank 13, each open into the compartment 36. A flange 69 of a discharge part 15 of pump 11 is secured to under wall 67, the discharge flow path extending through part 15, aperture 65 and a short length of pipe 70, the lower end of which pipe is sealed to under wall 67 within the aperture 65. The upper end of pipe 70 is sealed within an aperture 71 of a partition plate 72, which plate divides the compartment 36 into upper and lower portions, aperture 66 opening into the upper portion. A flap valve 37 within the upper portion of the compartment 36 is pivotally mounted on a hinge pin 73 which is secured within the compartment. The valve 37 serves as a discharge check valve and in its natural state of repose it is in the closed condition, as shown in Figure 2, in which it seats on an upper, seating surface 74 of the partition plate 72. Removal of a cover plate 82, secured to end wall 81, provides access to the flap valve 37.

When the pump unit is inoperative, the floats 22 and 23 are at their lowermost positions, with the float arms 26 and 33 both abutting the stop bar 80. With float arm 26 in such position the peeler valve 24 is in an open condition. Snifter valve 25 is closed, the valve spindle 57 thereof being at the lowermost extent of its vertical movement.

Suppose now that the suction pipe member 12 is connected, by suction pipe means (not shown), to a body of water and the engine unit 10 is started and run continuously. The vacuum pump 16 draws air from the float chamber 21 and from the casing of pump 11 via the open peeler valve 24. By virtue of the lowering in the pressure in the float chamber thereby produced, water is drawn along the suction pipe means and enters the float chamber 21, via aperture 44 of the suction pipe member 12, and the casing of the pump 11.

Initially the flap valve 37 is in its closed condition. However, as the water rises within the casing of the pump 11, the amount of water present therein eventually becomes sufficient to prime the pump, which then begins to deliver water through the discharge pipe member 15, thus causing the flap valve 37 to open.

Inflow of water into the float chamber 21 causes the floats 22 and 23 to rise and the float arms 26 and 33 to pivot upwardly about their respective hinge pins 32 and 34. When the water has reached a predetermined level, above the minimum level corresponding to a primed condition of the pump, the peeler valve 24 is thus caused to close, the float chamber being thereby isolated from the suction side of the vacuum pump 16. Should the water level in the float chamber 21 continue to rise after the peeler valve 24 has closed, the striker plate 35 secured to float arm 33 will eventually come into contact with the lower end of the valve spindle 57 of snifter valve 25. Any further upward movement of the float 23 causes the spindle 57 to move upwardly, against a force generated by the difference in pressure existing between the float chamber 21 and the compartment 56 of the tank 13, the pressure in the latter being, of course, atmospheric pressure. Atmospheric air then passes through the snifter valve 25, thus reducing the vacuum in the float chamber 21 and thereby also reducing the differential between the pressure at the surface of the body of water being pumped and that existing above the water in the chamber. This results, of course, in a lowering of the water level in the float chamber.

As the water level descends, so then does the float 23, and the snifter valve 25 is permitted to resume its closed condition, so that the float chamber 21 is again isolated from the atmosphere. The float 22 also falls with the water level and so the peeler valve 24 is put once more into its open condition. The suction side of the vacuum pump 16, which has been running continuously since engine unit 10 was started, is thus reconnected with the float chamber 21.

So long as water continues to flow through the suction pipe means under the action of the pump 11, water will be present in the float chamber 21 and this will maintain the pump 11 in a primed condition even should there occur a momentary reduction in the flow rate of water through the suction pipe means.

The further rise in the level of water in the float chamber after the peeler valve 24 has just become closed may occur by reason of the momentum of the water, which is moving upwardly under the action of the vacuum pump 16 before such closure occurs. If the water being pumped is heavily impregnated with air, this, in rising in the float chamber 21 may cause a violent agitation of the water surface, which will tend to produce a rapid upward and downward movement of the floats 22 and 23, thereby promoting rapid repetition of the above described cycle of opening and closing of the peeler and snifter valves.

The closure of the peeler valve 24 occurs when the water in the float chamber 21 is at such level as to obviate the danger of water in bulk passing over to the vacuum

pump 16. The opening of the snifter valve 25 provides for a limitation of the height to which water can rise in the float chamber 21, and the subsequent opening of the peeler valve when the water level consequently descends, tends to limit the lowest level reached before the water is once again caused to rise under action of the vacuum pump.

It will be noted in Figure 2 that although the float 23 is in its lowermost position, the float 22 is in a somewhat higher position. This relative positioning is merely for the sake of clear illustration of the two floats and float arms.

WHAT WE CLAIM IS:—

1. A centrifugal pump; a chamber disposed generally above the suction inlet thereof; means defining a liquid flow path extending from the suction inlet to the chamber interior; a vacuum pump; means defining a first air flow path extending from the chamber interior, at an upper part thereof, to the suction inlet of the vacuum pump; means defining a second air flow path extending from the chamber interior, at an upper part thereof, to atmosphere; first valve means, responsive to changes in level of liquid in the chamber so as to maintain closed the first air flow path if said liquid is above a first level; and second valve means, independent of the first, responsive to changes in level of liquid in the chamber so as to maintain closed the second air flow path if said liquid is at or below a second level and to maintain open the second air flow path if said liquid is above the second level, the second level being above the first level and both first and second levels being below the chamber ends of the air flow paths and above the chamber end of the liquid flow path.

2. Apparatus as claimed in Claim 1, in which the first valve means includes a peeler valve and a float, which float is movable with the surface of liquid in the chamber to actuate the valve.

3. Apparatus as claimed in either of Claims 1 and 2, in which the second valve means is actuatable by means of a float movable with the surface of liquid in the chamber.

4. Apparatus as claimed in any preceding claim, in which the chamber is provided by part of the interior of a tank which includes a partition separating the chamber from a further, upper part of the tank interior, which further part provides a part of the first flow path.

5. A pump unit including a centrifugal pump, a chamber disposed generally above the suction inlet of the centrifugal pump, the chamber being in communication with the said inlet, and a vacuum pump, in communication on its suction side with the chamber, wherein, when the pump unit is to be brought into operation for the purpose of pumping liquid, the vacuum pump is started and draws air from the chamber and from the casing of the centrifugal pump via the chamber, the centrifugal pump being thereby put into a primed condition, and wherein a first valve, actuated by a first float, which rises and falls with the level of liquid in the chamber, closes to isolate the chamber from the vacuum pump when the liquid reaches a first level in the chamber, and, if the liquid level continues to rise and reaches a second level, a second valve, actuated by a second float, which rises and falls with the level of liquid in the chamber, opens to put the chamber, above the liquid therein, into communication with atmosphere, whereby the liquid level in the chamber falls, thus permitting the second valve to close and then the first valve to open again.

6. A method of operation of a pump unit as claimed in Claim 5, in which throughout the running of the centrifugal pump the vacuum pump is also run.

7. A pump unit constructed and arranged to operate substantially as herein described with reference to the accompanying drawings.

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Sheet 1

FIG.1

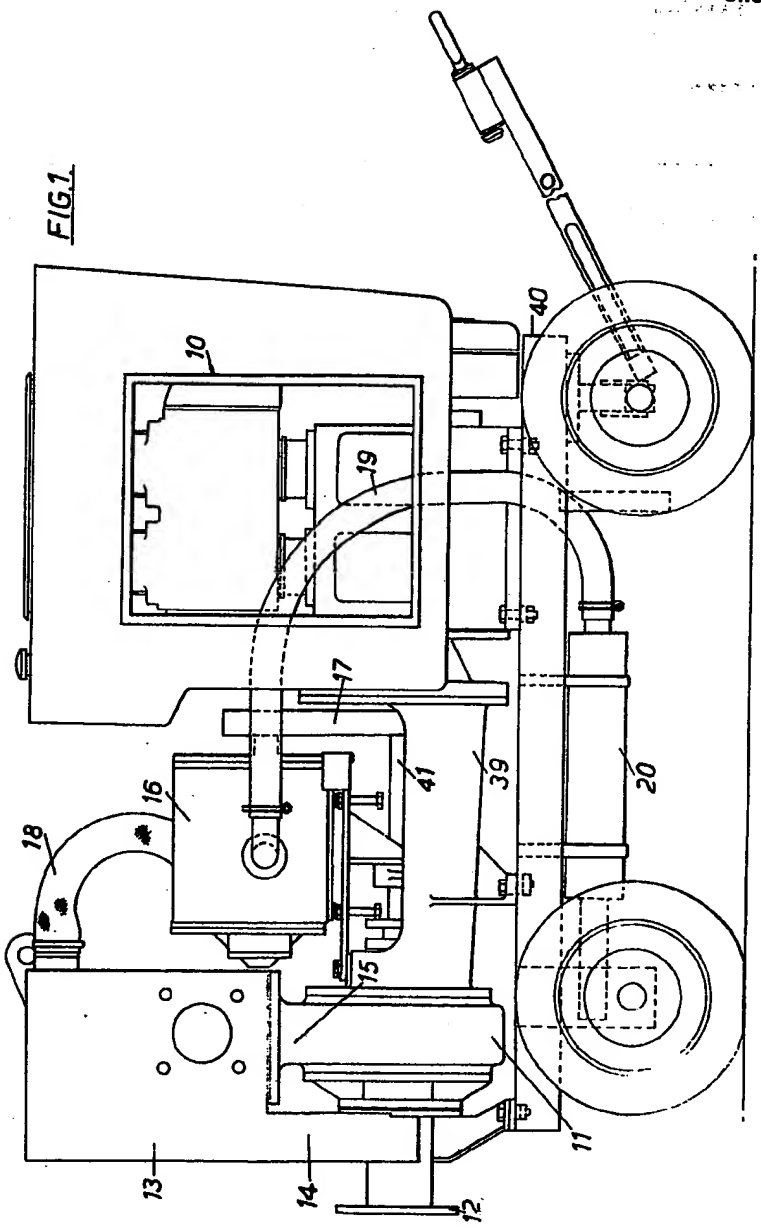

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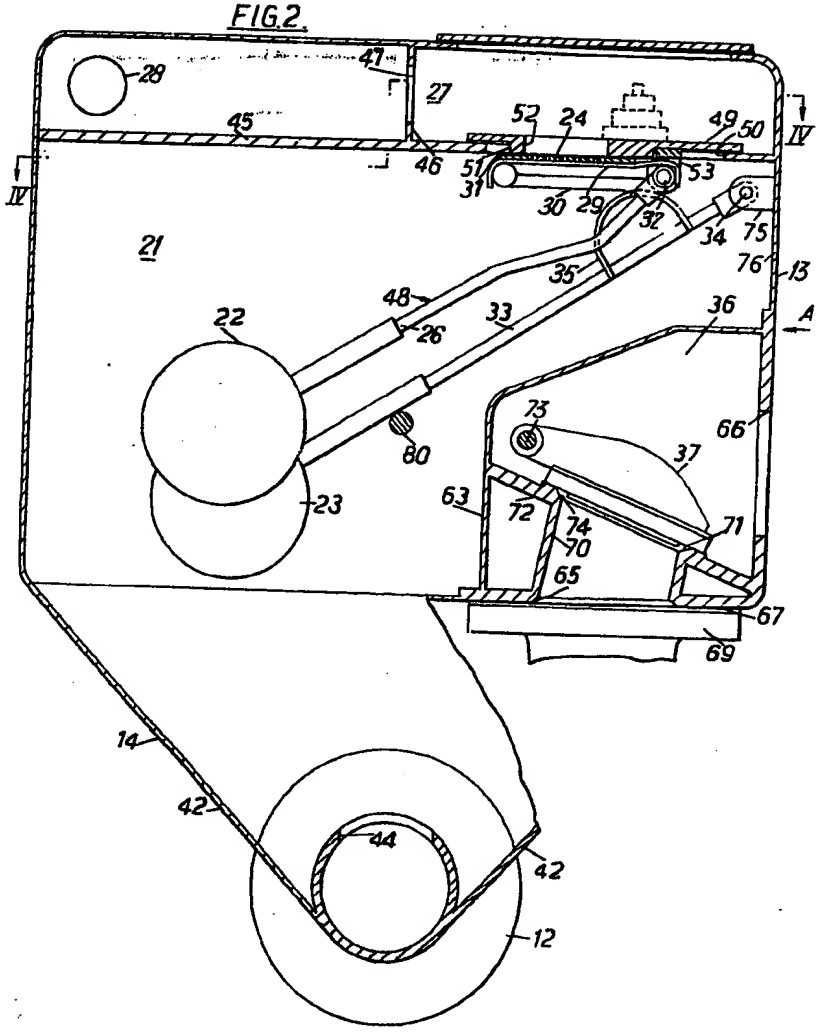
FIG.2.



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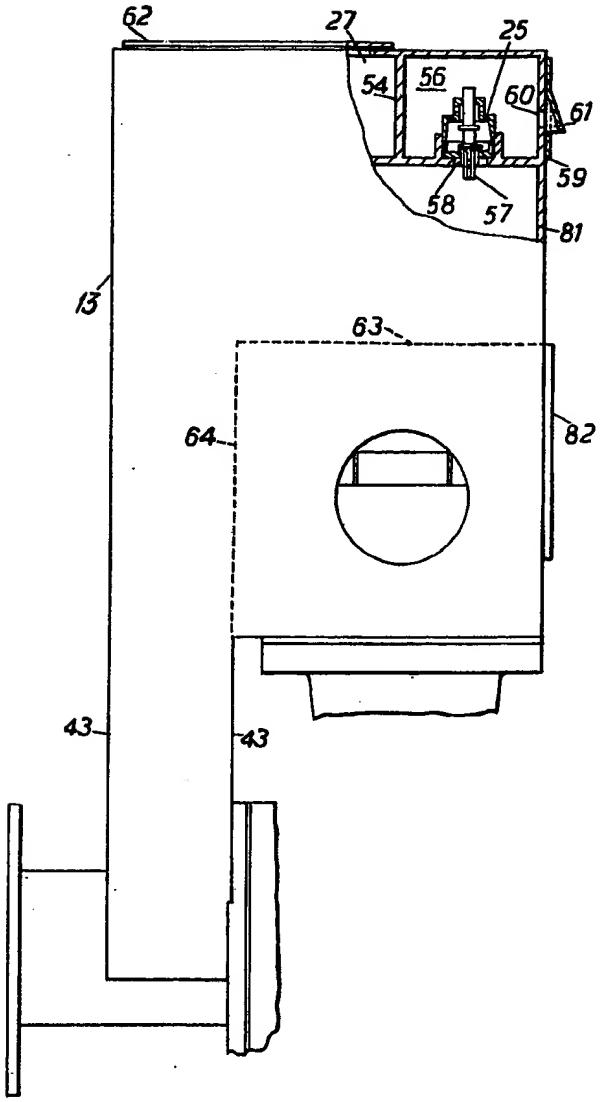
Sheet 3

FIG.3



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Sheet 4

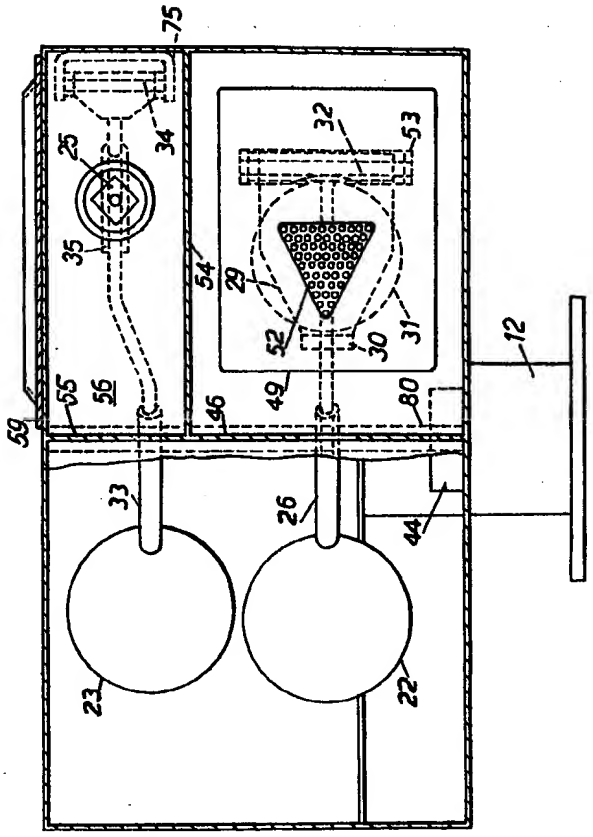

FIG.4